



## **Ecosystem-based Regional Marine Conservation Planning: The Nature Conservancy's Approach to Ecoregional Assessments in the Marine Environment**

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### **Abstract**

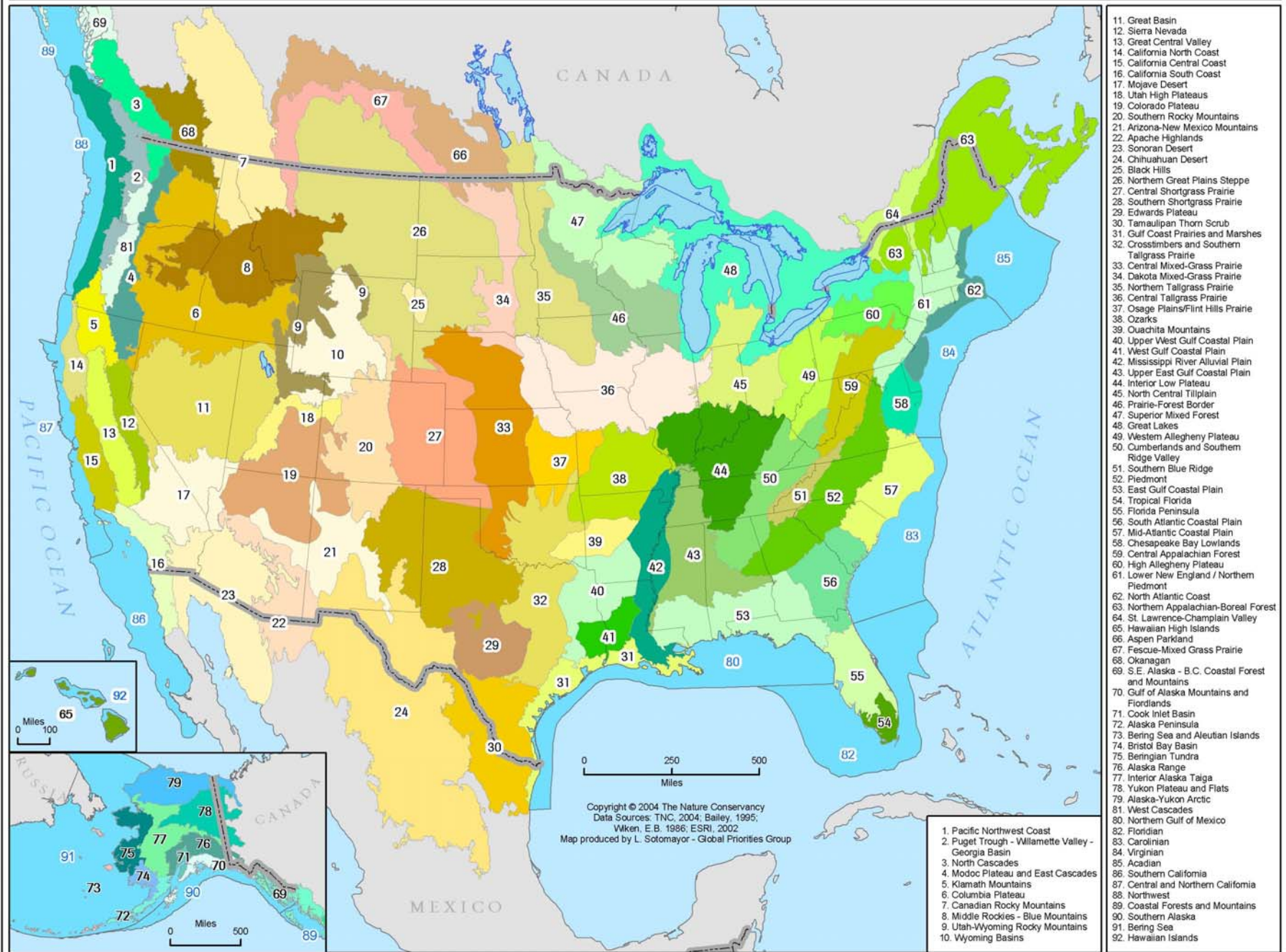
The Nature Conservancy is working with government agencies, marine stakeholders, communities, and others to develop ecoregional assessments that support decisions and actions for marine conservation and management. The ecoregional assessment process encourages the participation and support of all local stakeholders, from governments to conservationists, communities and industry, to lay the foundation for a shared vision for regional ecosystem management. These assessments are based on a consistent process which is sufficiently robust for comparable purposes yet flexible enough to meet the needs of local partners and stakeholders. Each ecoregional assessment is based on establishing a specific list of conservation targets (species and ecosystems) and the creation of an information resource which integrates available data on the spatial distribution of each target, or in some cases modeled surrogates. Targets are then represented in a decision making platform which enables us to balance ecologically driven goals against threats, opportunities, and stakeholder input to enable an ecosystem-based management framework. TNC typically employs decision support software such as Marxan and a comprehensive spatial information resource such as a Marine Geodatabase to develop a vision for successful stewardship of natural resources. By building distributable information resources and providing an integrated view of ecological objectives and threats assessment, the ecoregional assessment process supports the adoption of an ecosystem-based management perspective by resource management agencies and stakeholders. The process can be used to identify a set of priority areas for focusing management attention such as a network of sites or it can be used to support individual decisions made within the context of a broader ecosystem.

# MARINE ECOREGIONAL PLANNING



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Global Marine Initiative, September 2004  
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# Terrestrial and Marine Ecoregions of the United States







- Identify conservation targets-- ecosystems & spp.
- Collect the available information on targets
- Set conservation goals
- Develop “strawman” set of priority sites using a reserve selection program
- Evaluate these mathematical results in wkshops and interviews with scientists & managers
- Finalize the portfolio of sites into an ecoregional plan

**SOUTHERN CALIFORNIAN MARINE ECOREGION:  
TARGET LIST – Fine Filter**

**Fine-filter Targets:**

**Species\***

**11 mammals**

**15 birds**

**7 fish**

**5 invertebrates**

**\*(SCCWRP trawl, NDDb,  
REEF, MMS, and ESI)**

Ashy storm-petrel

Bald eagle

Black skimmer

Black storm-petrel

Black tern

Brown pelican

California gull

California least tern

Common loon

Double-crested cormorant

Elegant tern

Forktailed storm-petrel

Rhinoceros auklet

Tufted puffin

Xantus murrelet

Boccacio

California Halibut

Coho

Cowcod

Sheephead

Steelhead

Tidewater goby

Abalone

Black Abalone

Purple Urchin

Red Urchin

Sea Star

Blue whale

Fin whale

Gray whale

Guadalupe fur seal

Harbor porpoise

Humpback whale

Northern elephant seal

Sei whale

Shortfinned pilot whale

Southern sea otter

Sperm whale

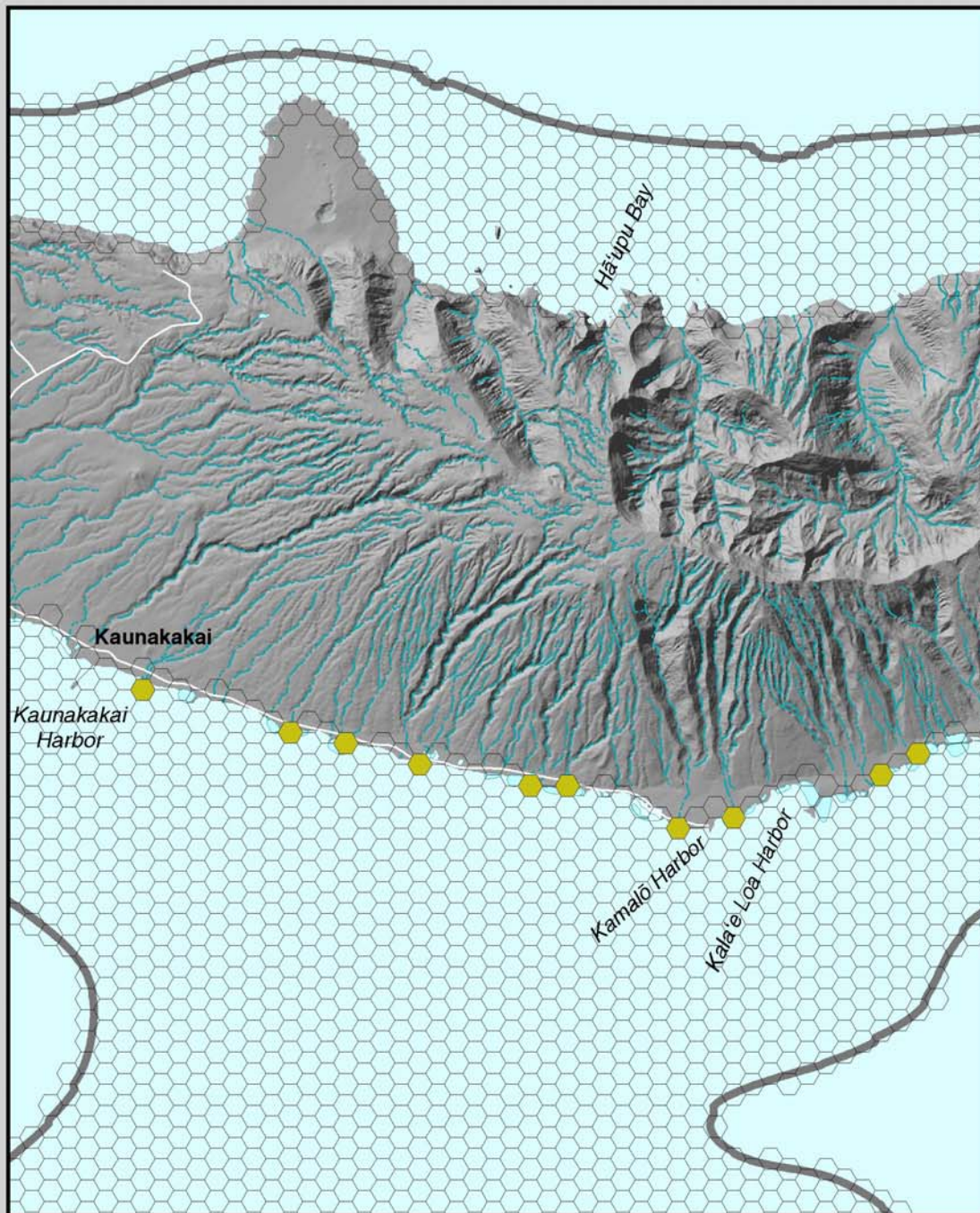
# Gulf Sturgeon – Fine Filter Target



© Noel M. Burkhead

*Acipenser oxyrinchus desotoi*





# Fish Spawning Sites Island of Moloka'i

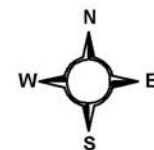
Marine Gap Analysis

- Fish Spawning (January to December)
- Site Analysis Units (25 ha.)

- Study Area (200 meter contour)
- Bathymetry (1000 meters)

- Mangrove
- Marsh
- Water Body
- Tidal Flat

- Streams
- Perennial
- Intermittent

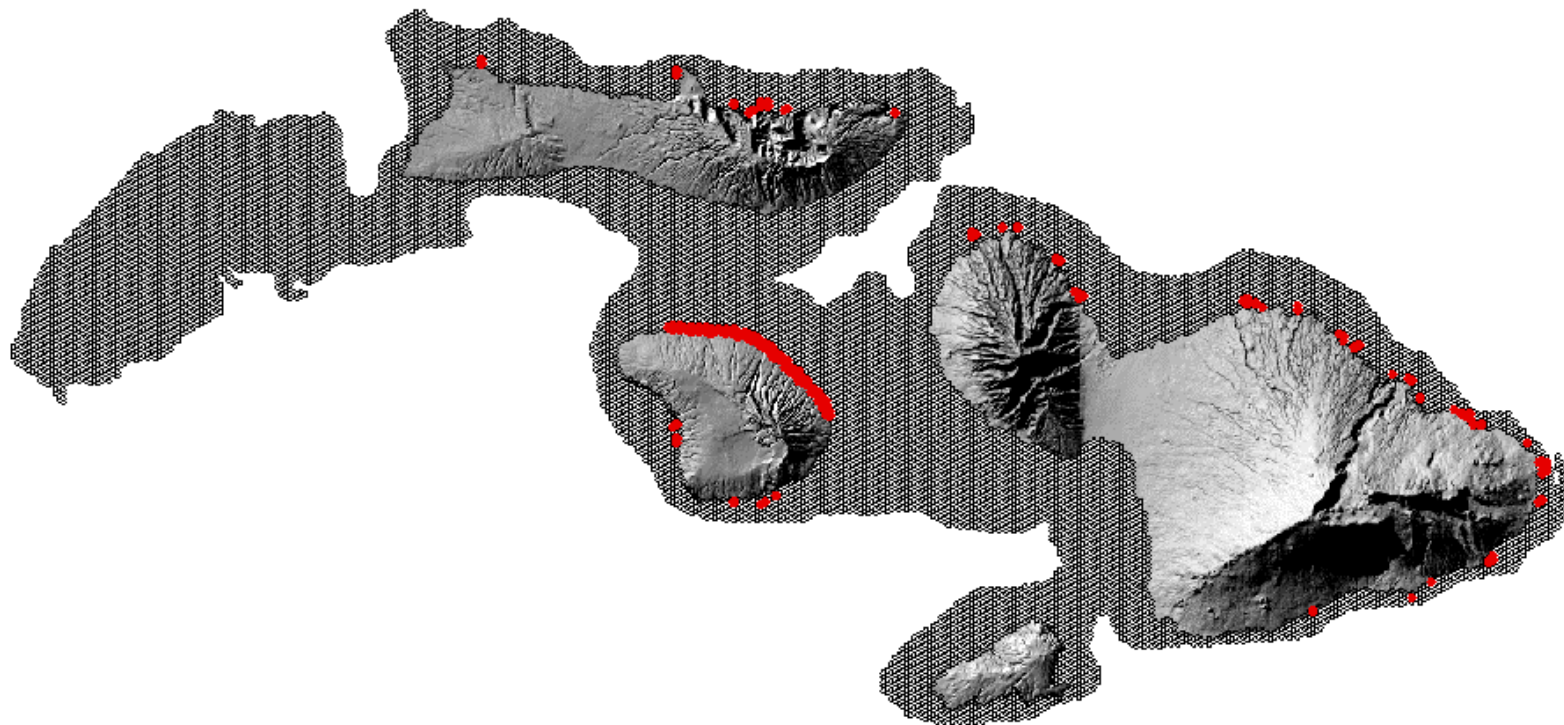


5 0 5 Kilometers



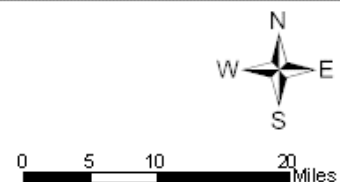
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 Marine Intertidal

Goal 60%  
Nursery or recruitment site  
Area Goal 351.88 Hectares




# Benthic Habitat Island of O'ahu

Marine Gap Analysis

## Benthic Habitat

- Artificial/Fish Ponds
- Artificial/Hardened Substrate
- Artificial/Other Man Made Structures
- Emergent Vegetation
- Encrusting Coralline Algae/10-50%
- Encrusting Coralline Algae/50-90%
- Hardbottom/Reef Rubble
- Hardbottom/Uncolonized Pavement
- Hardbottom/Uncolonized Pavement with Channels
- Hardbottom/Uncolonized Volcanic Rock/Boulders
- Macroalgae/10-50%
- Macroalgae/50-90%
- Macroalgae/Continuous
- Reef/Aggregate Coral
- Reef/Colonized Pavement
- Reef/Colonized Pavement with Channels
- Reef/Colonized Volcanic Rock/Boulders
- Reef/Linear Reef
- Reef/Patch Reef (Individual)
- Reef/Scattered Coral-Rock
- Reef/Spur and Groove Reef
- Sand
- Mud
- Land
- Unknown

 Study Area (200 meter contour)

 Bathymetry (1000 meters)

Streams:

 Perennial

 Intermittent

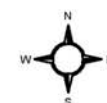
Water Body:

 Pond

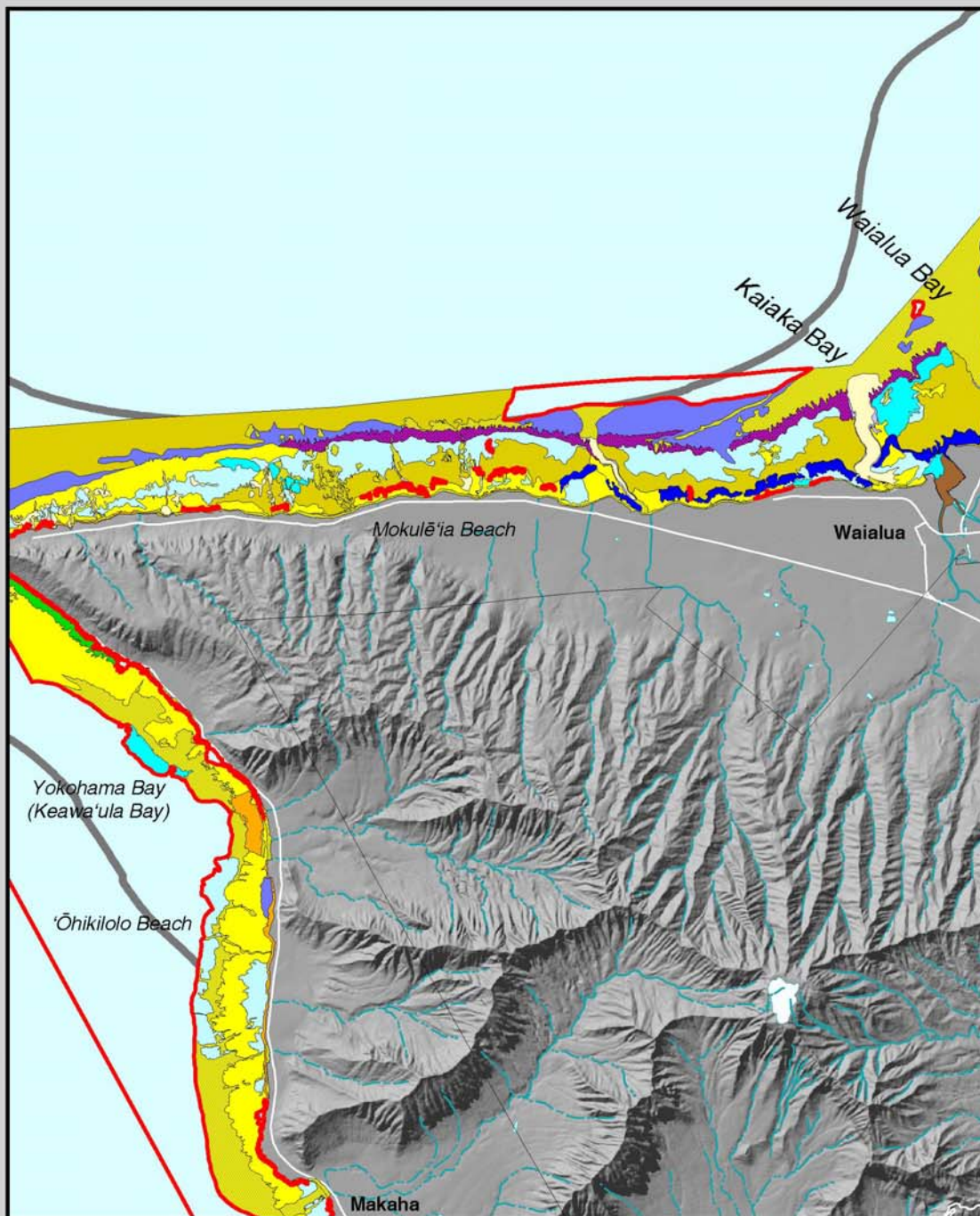
 Mangrove

 Marsh

1 0 1 2 3 4 5 Kilometers



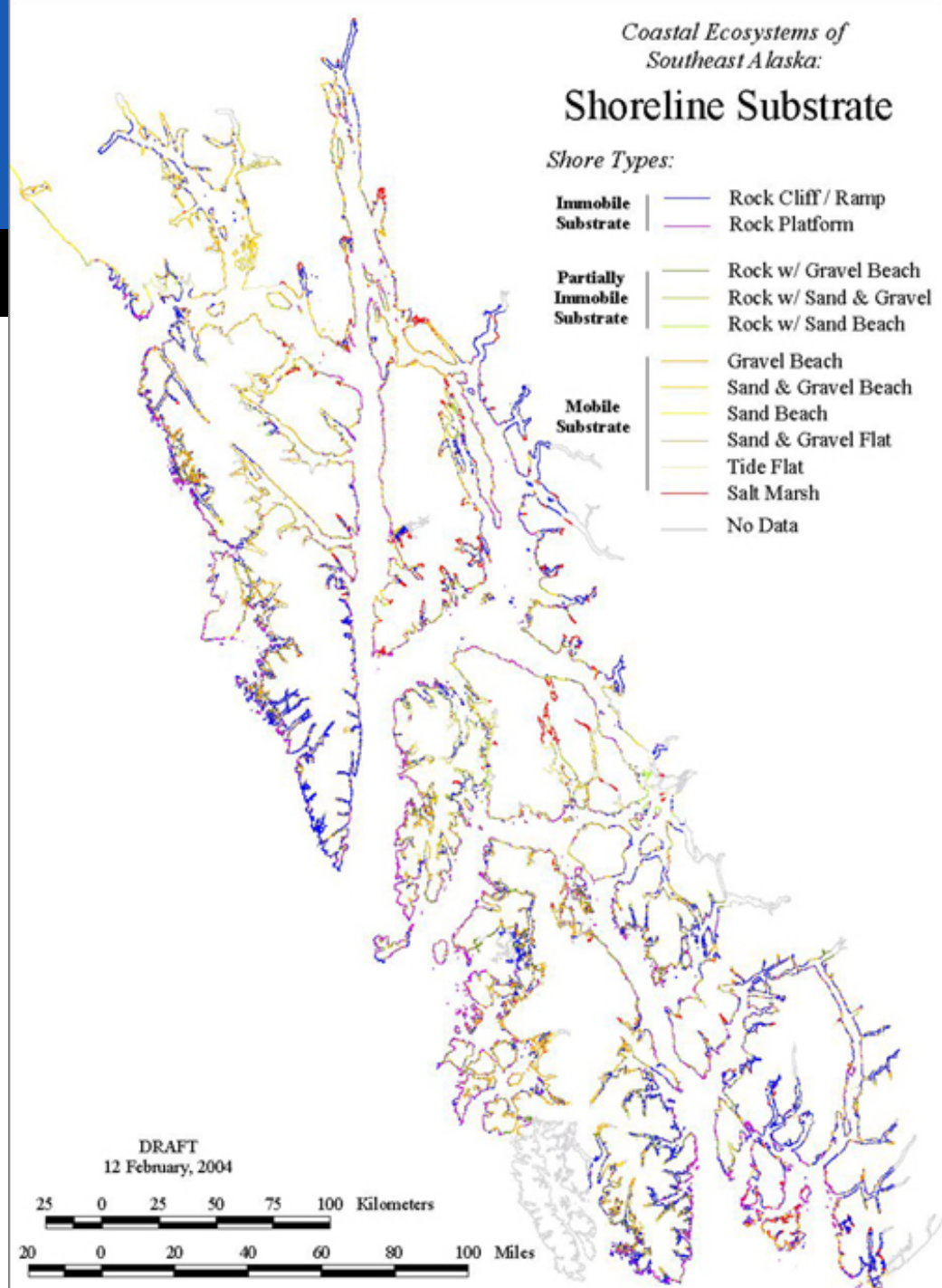
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# Shoreline Characterization: NOAA – Environmental Sensitivity Index

Substrate Type	Length (km)
Rocky Shore / Cliff	7,051
Rock Platform	3,823
Rock w/ Gravel Beach	2,435
Rock w/ Sand & Gravel	510
Rock w/ Sand Beach	445
Gravel Beach	4,084
Sand & Gravel Beach	1,512
Sand & Gravel Flat	1,655
Sand Beach	73
Tide Flat	1,608
Salt Marsh	1,531
No Data	3,808
Grand Total	28,536

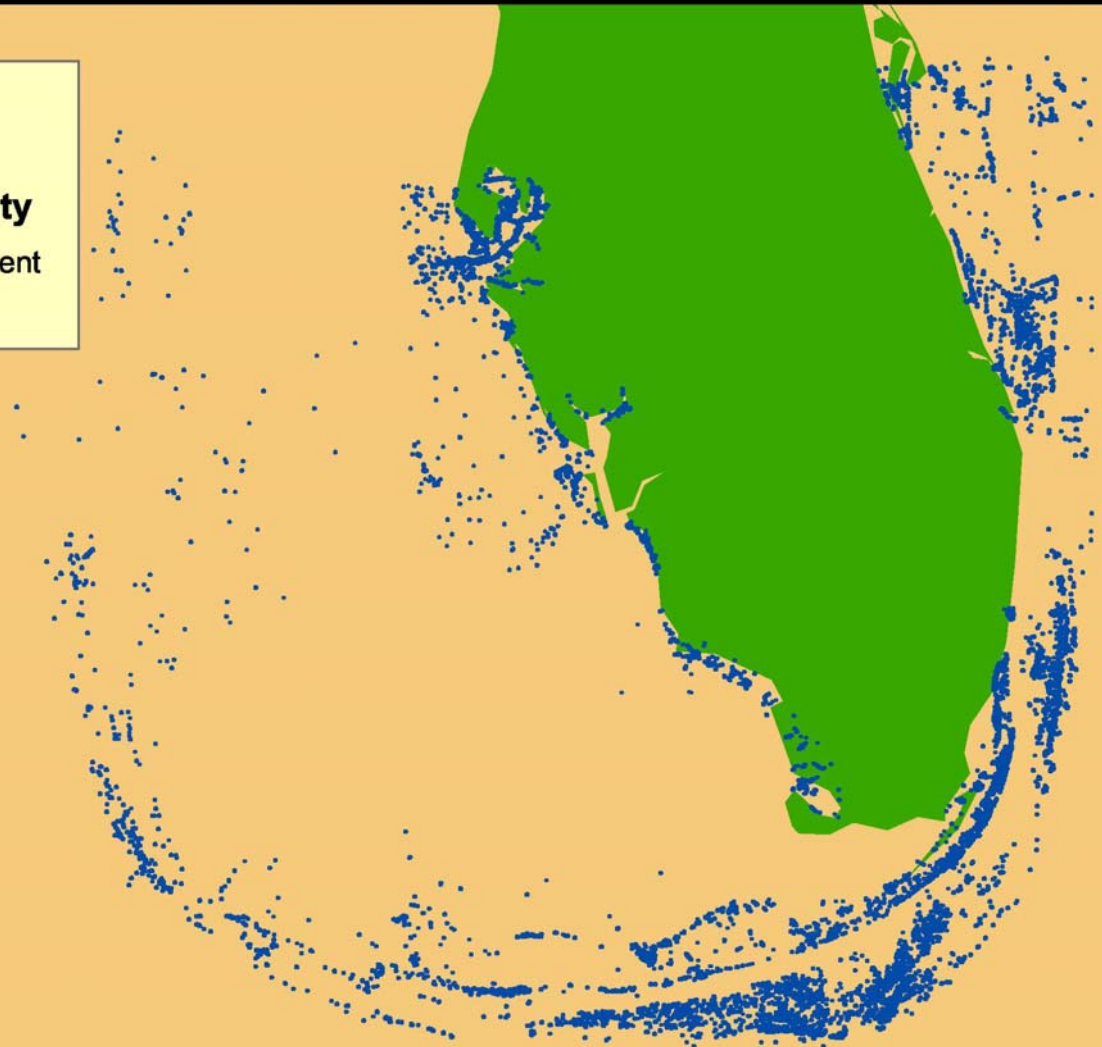




# Developing Surrogates Where Information is Sparse

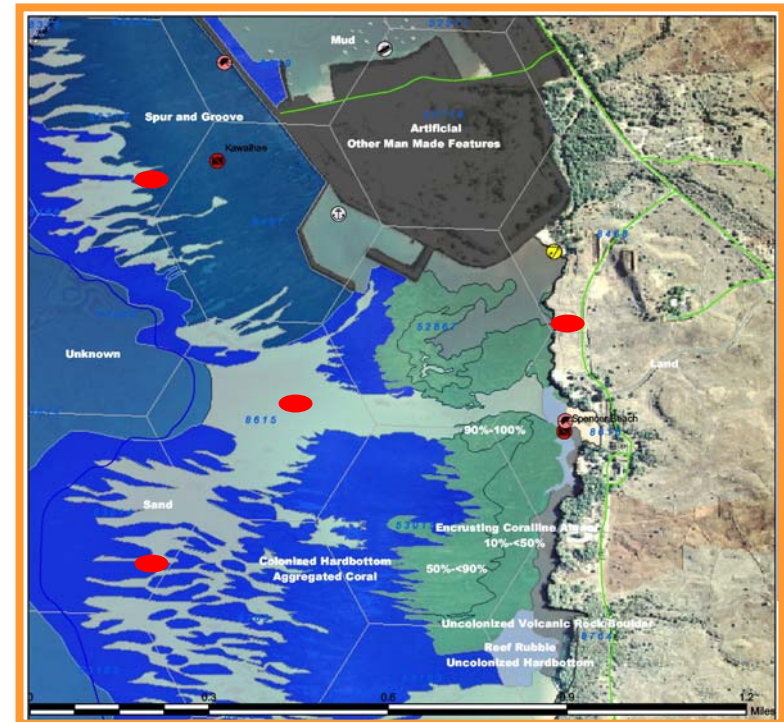
**Bottom  
Complexity  
Model:**

**Experimental  
Technique Using Broad  
Scale  
Data  
Developed  
by  
Nicholas School for the  
Environment, in  
partnership with TNC &  
EPA**



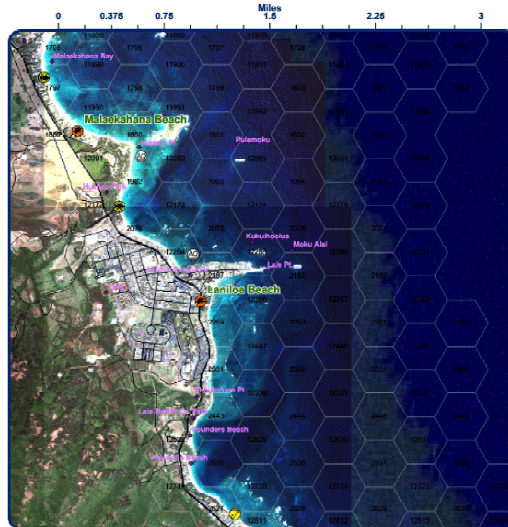
## Formats of original data

- Maps, Places
  1. NOAA benthic habitat maps
  2. State GIS site
- Models of distribution
  - Ecological Sensitivity Index
- Actual sightings/ transects
  1. Fish
  2. Algae
  3. Invertebrates
  4. Mammals / Reptiles



## Data resurrection

- Paper reports
- Published literature
- Personal collections
- Old maps



### Appendix C

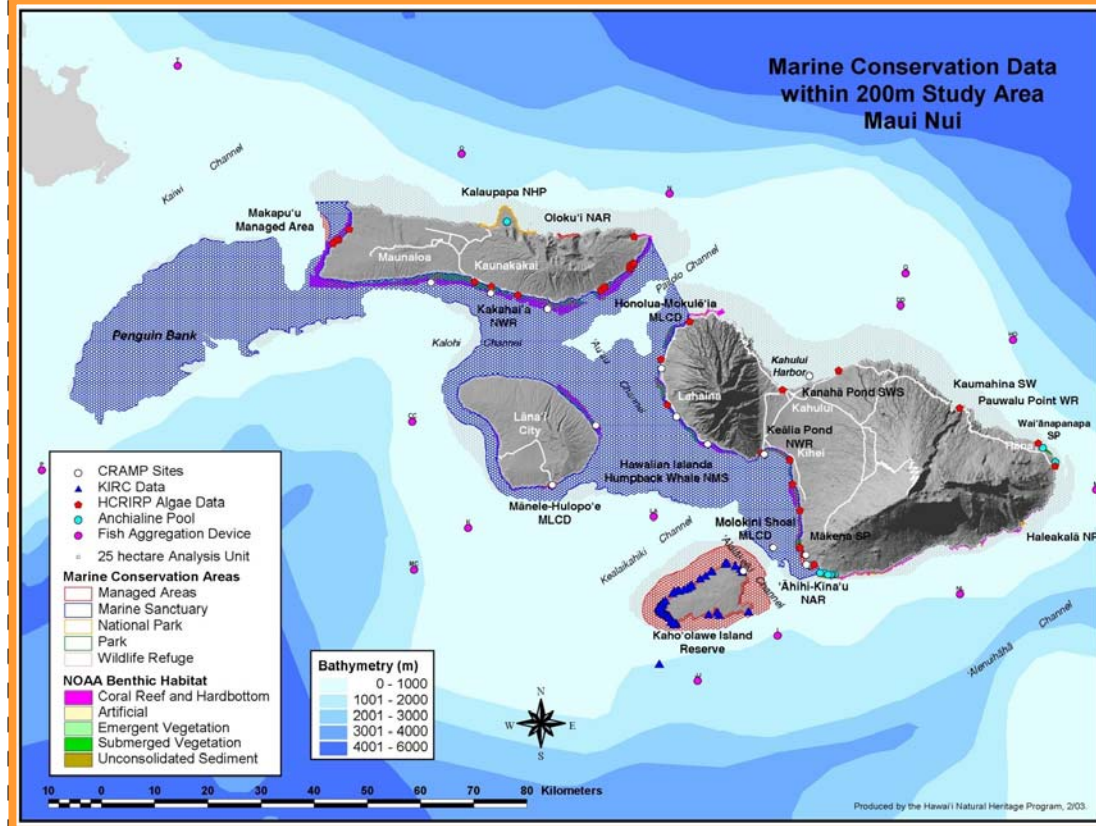
Taxa	Genus	Species	Author, Date	Hawaiian Name	Station						
					1	2	3	4	5	6	7
Cyanophyta	<i>Phormidium</i>	<i>crocyanum</i>									1
Chlorophyta	Unident.	sp.						1			
	<i>Caulerpa</i>	<i>taxifolia</i>	(Vahl) C. Ag.		1		1	1			1
	<i>Halimeda</i>	<i>opuntia</i>	(Linnaeus) Lamouroux								1
	<i>Halimeda</i>	sp.			1	1	1	1	1	1	1
	<i>Siphonocladus</i>	<i>tropicus</i>	(Crouan) J. Ag.								1
Phaeophyta	<i>Ventricaria</i>	<i>ventricosa</i>			1		1	1			
	<i>Dictyopteris</i>	<i>plagiogramma</i>	(Montagne) Vickers	<i>Lipoa</i>	1					1	1
	<i>Dictyota</i>	<i>friabilis</i>	Setchell	<i>Alani</i>	1		1	1	1	1	1
	<i>Lobophora</i>	<i>variegata</i>	(Lam.) Womersley		1						1
	<i>Padina</i>	<i>japonica</i>	Boergesen								1
Rhodophyta	<i>Padina</i>	sp.			1	1	1	1	1	1	1
	<i>Acanthophora</i>	<i>pacifica</i>	(Setch.) Kraft			1			1		1
	<i>Actinotricia</i>	<i>fragilis</i>	(Forssk.) Borg.						1	1	1
	<i>Ceramium</i>	<i>dumosertum</i>			1		1	1		1	
	<i>Galaxaura</i>	<i>marginata</i>			1	1	1	1			1
	<i>Gibsmithia</i>	<i>hawaiiensis</i>	Doty								1
	<i>Haloptilon</i>	<i>subulatum</i>									1
	<i>Haloplegma</i>	<i>duperreyi</i>	Montagne							1	1
	<i>Hypnea</i>	<i>pannosa</i>	J. Ag.							1	1
	<i>Jania</i>	<i>mcarthroidia</i>	Lamour.		1	1	1	1	1	1	1
Total Algae	<i>Melanamansia</i>	<i>demellyi</i>			1	1	1	1		1	1
	<i>Portieria</i>	<i>homemanni</i>			1	1			1	1	1
	<i>Spyridia</i>	<i>filamentosa</i>	(Wulf.) Harvey								1
	<i>Taenioma</i>	<i>purpusillum</i>	(J. Ag.) J. Ag.								1
					12	7	9	20	4	13	16
	<i>Batzella</i>	sp.				1					1
	<i>Cacospongia</i>	sp.									1
	<i>Clathria (Microciona)</i>	sp.				1				1	1
	<i>Dactylospongia</i>	n. sp.									1
	<i>Erylus</i>	<i>proximus</i>	de Laubenfels, 1952					1			
	<i>Hippospongia</i>	<i>metachromia</i>	Bergquist, 1967		1				1	1	
	<i>Hippospongia</i>	sp.									1
	<i>Leiodermatium</i>	sp.			1			1		1	
	<i>Leiosella</i>	sp.									1
	<i>Lucetta</i>	sp.			1	1	1	1	1	1	1
	<i>Plakortis</i>	sp.								1	1
	<i>Spheciospongia</i>	<i>vagabunda</i>	(Ridley, 1884)		1	1			1		
	<i>Spongia</i>	<i>oceanica</i>	Bergquist, 1979		1			1	1	1	
	<i>Tolithus</i>	<i>diplodermis</i>	Sakuma, 1993								1



# Single Comprehensive Marine Ecoregional Geodatabase

- mpa\_maui\_cnty\_SHAPE\_Index
- mpa\_summary
- m\_mammal
- National\_Park\_Service\_Data\_Maui\_cnty
- National\_Park\_Service\_Data\_Maui\_cnty\_SHAPE\_Index
- National\_Park\_Service\_hawaii
- National\_Park\_Service\_hawaii\_SHAPE\_Index
- National\_Park\_Service\_Maui
- National\_Park\_Service\_Maui\_SHAPE\_Index
- National\_Park\_Service\_Molokai
- National\_Park\_Service\_Molokai\_SHAPE\_Index
- National\_Park\_Service\_molokai
- National\_Park\_Service\_molokai\_SHAPE\_Index
- noaa\_benthic\_habitat\_data\_maui\_cnty
- noaa\_benthic\_habitat\_data\_maui\_cnty\_SHAPE\_Index
- NOAA\_bird\_data\_hawaii
- NOAA\_bird\_data\_hawaii\_SHAPE\_Index
- NOAA\_cass\_pt\_data\_hawaii
- NOAA\_cass\_pt\_data\_hawaii\_SHAPE\_Index
- NOAA\_ESI\_bathy\_hawaii
- NOAA\_ESI\_bathy\_hawaii\_SHAPE\_Index
- NOAA\_ESI\_birds\_hawaii
- NOAA\_ESI\_birds\_hawaii\_SHAPE\_Index
- NOAA\_ESI\_birds\_kahoolawe
- NOAA\_ESI\_birds\_kahoolawe\_SHAPE\_Index
- NOAA\_ESI\_birds\_kauai
- NOAA\_ESI\_birds\_kauai\_SHAPE\_Index
- NOAA\_ESI\_birds\_lanai
- NOAA\_ESI\_birds\_lanai\_SHAPE\_Index
- NOAA\_ESI\_birds\_maui

- noaa\_esi\_birds\_maui\_cnty
- noaa\_esi\_birds\_maui\_cnty\_SHAPE\_Index



- noaa\_esi\_esil\_maui\_cnty
- noaa\_esi\_esil\_maui\_cnty\_SHAPE\_Index
- NOAA\_ESI\_esil\_molokai

# Benthic Habitat Island of O'ahu

Marine Gap Analysis

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Site Analysis Units (25 ha.)

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Bathymetry (1000 meters)

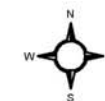
## Streams:

- Perennial
- Intermittent

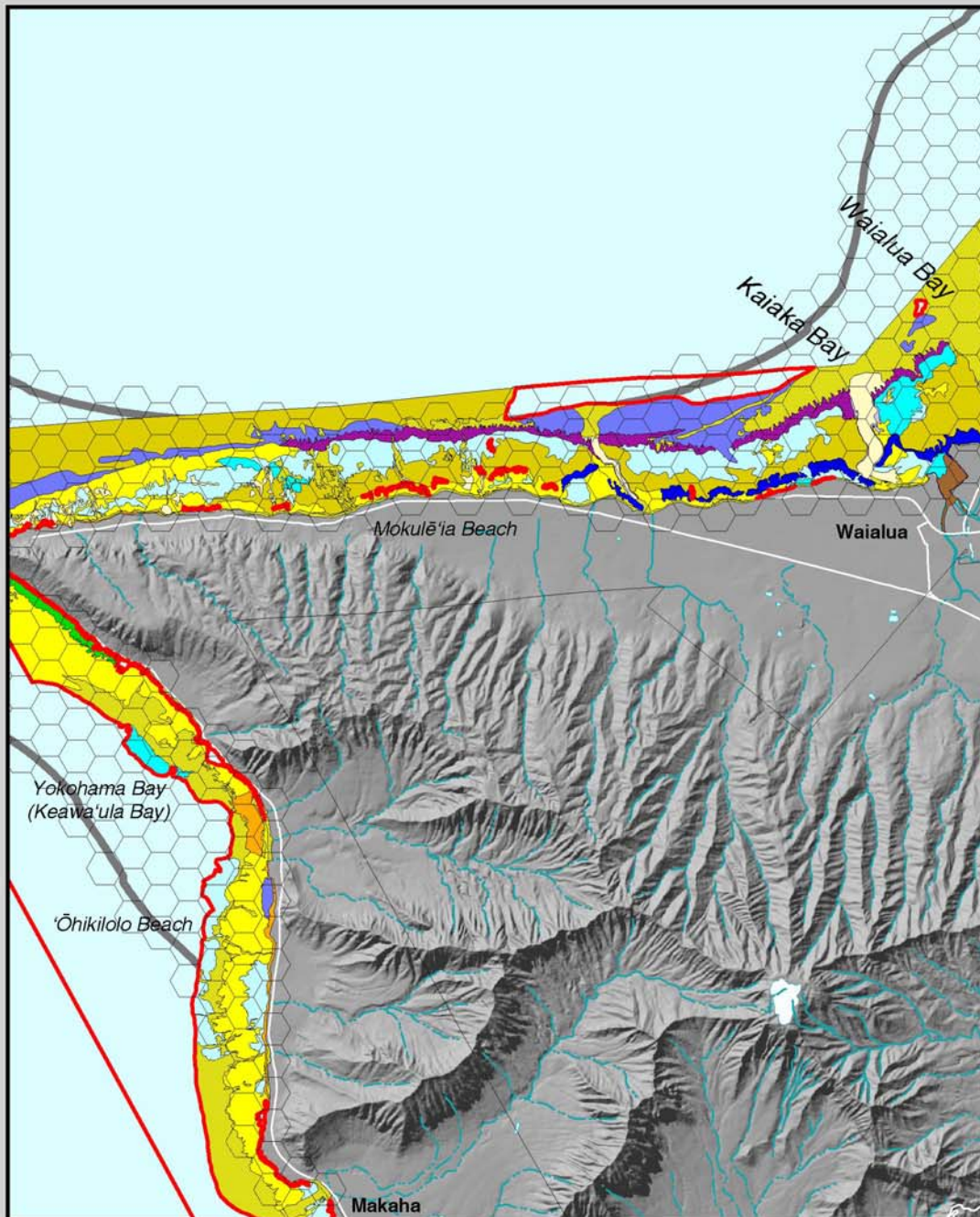
## Water Body:

- Pond
- Mangrove
- Marsh

1 0 1 2 3 4 5 Kilometers



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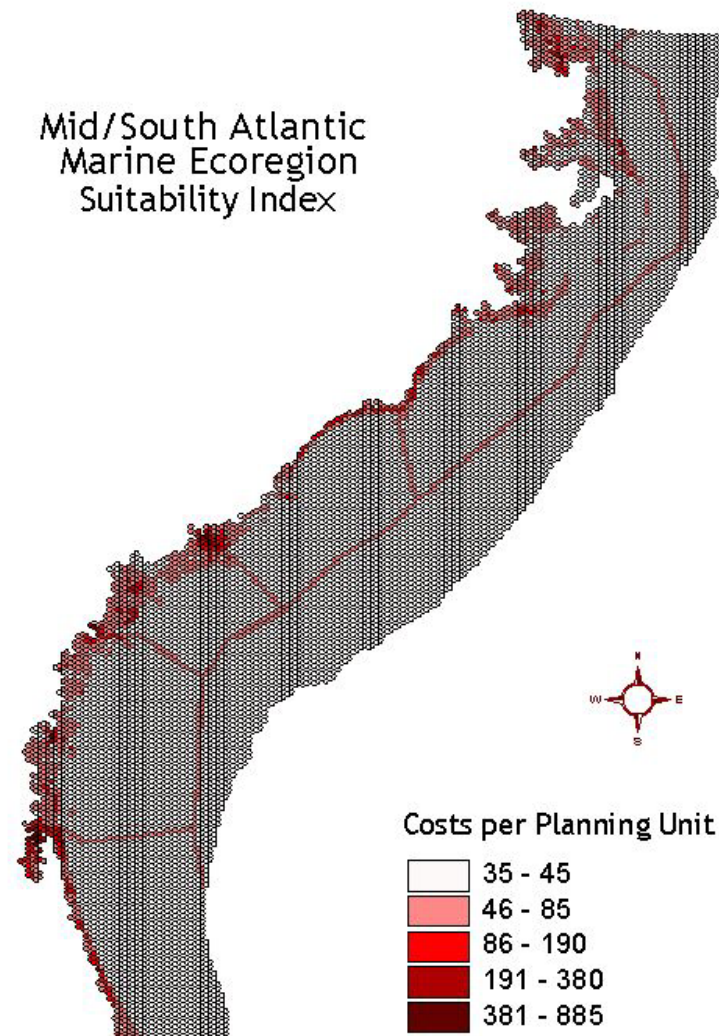




# Marine Ecoregional Assessment Mid/South Atlantic (Carolinian Province)

Factor	Unit	COST POINTS	Data Source
Basic cost per planning unit	11,903 planning units (1,500 hectare hexagons)	35	
Mean population change	1.- 10% increase 10 - 25% increase 25 - 50% increase > 50% increase	0 5 10 20	U.S. Census
Housing density	0 - 100 housing units 100 - 25 units 250 - 1000 units > 1000 units	0 5 10 20	U.S. Census
Road density	0 km 0 - 25 km 26 - 50 km > 50 km	0 5 10 20	U.S. Census
Major ports	# port facilities	5 each	ACOE-Navigation Data Center
Major shipping lanes	0 tons shipped 1 - 2 million tons 2 - 5 million tons 5 - 10 million tons > 10 million tons	0 5 10 15 20	ACOE-Navigation Data Center
Dredged shipping channels	# dredging projects	5 each	ACOE-Navigation Data Center
Hardened shorelines	0 km 1 - 10 km 10 - 20 km > 20 km	0 10 20 30	NOAA-ESI and NWI
Superfund sites	# sites	20 each	NOAA-OPIS
NPDES permits	# permits	5 each	NOAA-OPIS
Offshore dredge disposal sites	# sites	20 each	NOAA-OPIS

Mid/South Atlantic  
Marine Ecoregion  
Suitability Index





**Marxan attempts to minimize the total cost of a portfolio:**

$$Total\ Cost = \sum_i Cost\ site\ i \quad + \quad \sum_j Penalty\ cost\ for\ element\ j \quad + \quad w_b \sum boundary\ length$$

**Or in plain language,**

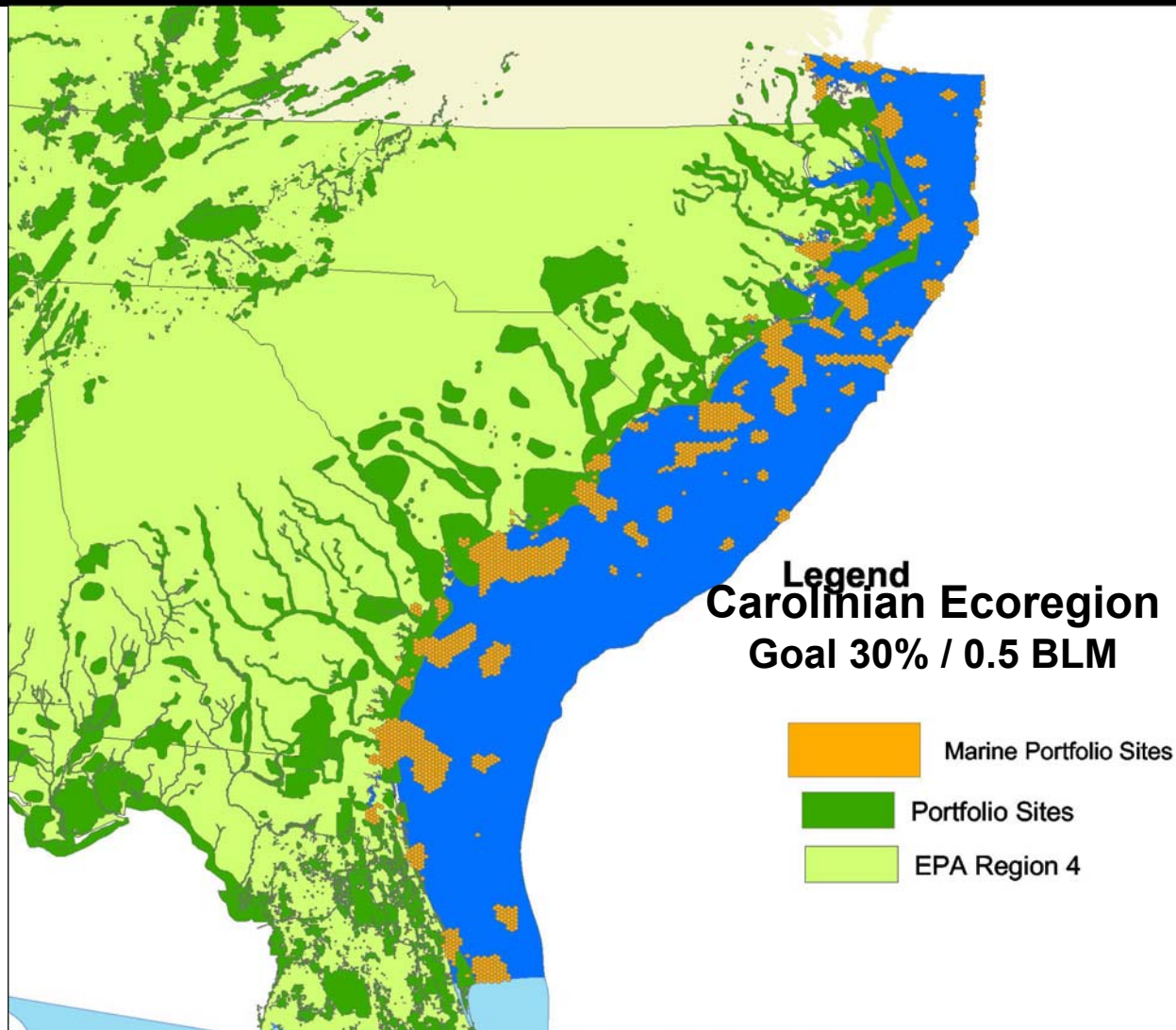
**Total Portfolio Cost =**

**(cost of selected sites) +**

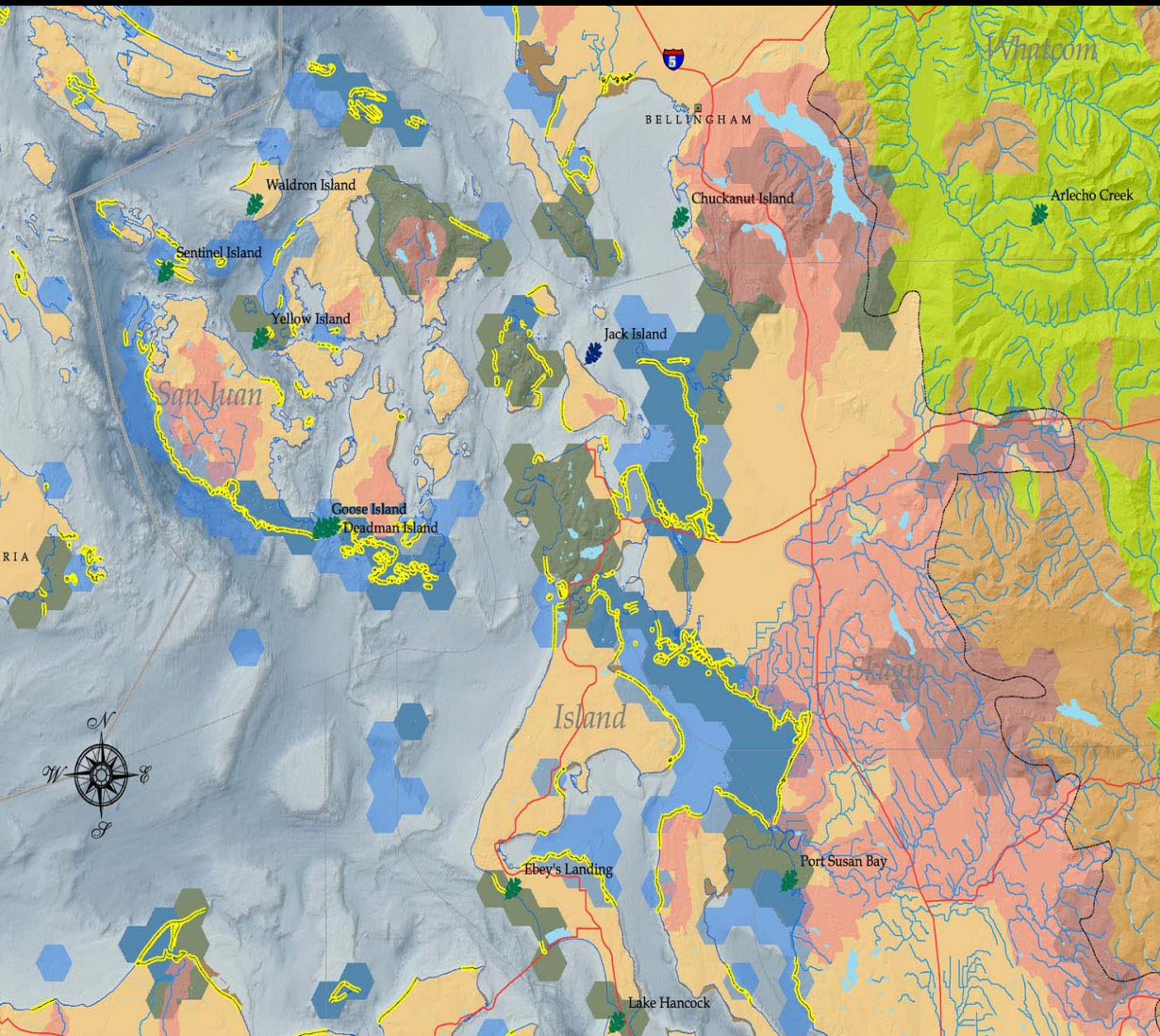
**(penalty cost for not meeting the stated conservation  
goals for each element) +**

**(cost of spatial dispersion of the selected sites as  
measured by the total boundary length of the portfolio).**

# Draft Set of Priority Areas Produced By Objective Decision Support System - Marxan



# Two Tiered Approach to Portfolio Assembly



**Marine, Terrestrial,  
and Freshwater  
Each run  
independently**

**Post Marxan  
adjustment for  
spatial & ecological  
efficiency**



# Innovative Nearshore Marine Conservation Strategies

- Ownership and leasing
- Restoration
- Nursery area protection
- Seas to summits
- Local partnerships
- Supportive policies



Great South Bay, New York

# Innovative Nearshore Marine Conservation Strategies

## *Replenishing hard clam populations, Peconic Bay,*

- Hard clam spawner sanctuaries established at 2 brown tide “hot spots”
- 140,000 clams placed in two sanctuaries in two years
- GOAL: Determine impact on preventing brown tide, increasing water quality and protecting aquatic vegetation. Re-establish ecosystem function.



# Community-Based Restoration

*2001-2003 NOAA partnership restoration sites*





# Marine Ecoregional Planning Applications:

- Regional Ecosystem-based Comprehensive Vision
- Provides Ecosystem Context for Local Management Decisions
- Identify Priority Areas for Ownership and Leasing of Submerged Lands
- Supports Regional Restoration Strategies (i.e. Puget Sound Nearshore Ecosystem Restoration Program)
- Encourages Ecosystem-based Management Partnerships
- Supports Policies Aimed at Advancing Marine Resource Conservation



Great South Bay, New York